

CLAIMS

What is claimed is:

- 5 1. A method of controlling a cryopump, the method comprising:
using local electronics coupled to a cryopump, responding to a
potentially unsafe condition in the cryopump by:
retaining a normally open purge valve closed for a predetermined
period of time; and
10 after the predetermined period of time elapses, allowing the purge
valve to open to emit a purge gas into the cryopump.

15 2. A method of controlling a cryopump as described in Claim 1 wherein allowing
the purge valve to open to emit purge gas into the cryopump further includes
cycling between opening and closing the purge valve.

20 3. A method of controlling a cryopump as described in Claim 1 further includes
after the purge valve has been allowed to open, preventing any other system
from closing the purge valve until the potentially unsafe condition is corrected.

25 4. A method of controlling a cryopump as described in Claim 1 wherein the local
electronics further respond to the potentially unsafe condition by opening an
exhaust purge valve to emit a purge gas into an exhaust system coupled to the
cryopump.

5. A method of controlling a cryopump as described in Claim 4 wherein opening
the exhaust purge valve includes releasing a normally open valve.

6. A method of controlling a cryopump as described in Claim 4 wherein the local electronics coupled to the cryopump further respond to the potentially unsafe condition by cycling between opening and closing the exhaust purge valve.
- 5 7. A method of controlling a cryopump as described in Claim 4 wherein opening the exhaust purge valve includes preventing any other system from closing the exhaust purge valve until the potentially unsafe condition is corrected
- 10 8. A method of controlling a cryopump as described in Claim 1 wherein a potentially unsafe condition includes any of: a power failure of the cryopump; or a temperature of the cryopump greater than or equal to a predetermined temperature threshold; or an inability to determine a temperature of the cryopump.
- 15 9. A method of controlling a cryopump as described in Claim 8 wherein the response to a potentially unsafe condition that is a power failure further includes: determining an operating state of the cryopump before the power failure; and if the operating state indicates that the cryopump was in a process of regeneration when the power failed, determining whether initiating a regeneration process is possible.
- 20 10. A method of controlling a cryopump as described in Claim 1 wherein a potentially unsafe condition changes to a safe condition either after purge gas has been emitted into the cryopump for a period of time.
- 25 11. A method of controlling a cryopump as described in Claim 1 wherein the local electronics respond to a potentially unsafe condition that changes to a safe condition by determining whether regeneration of the cryopump is necessary.

12. A method of controlling a cryopump as described in Claim 1 wherein the local electronics coupled to the cryopump further respond to the potentially unsafe condition by preventing regeneration of the cryopump if a gate valve is open.
- 5 13. An electronic controller integral with a cryopump, the controller is configured to respond to a potentially unsafe situation in a cryopump by:
 - securing a normally open purge valve closed for a safe period of time;
 - and
 - directing purge gas into the cryopump when the safe period of time elapses by releasing the purge valve.
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14. An electronic controller as in Claim 13 wherein directing purge gas into the cryopump includes cycling between opening and closing the purge valve until the potentially unsafe situation is corrected.
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15. An electronic controller as in Claim 13 wherein the controller is further configured to respond to a potentially unsafe situation in a cryopump by preempting any attempts from any other systems to control the purge valve.
16. An electronic controller as in Claim 13 wherein the controller is further configured to respond to a potentially unsafe situation in a cryopump by directing purge gas into an exhaust line coupled to the cryopump by causing an exhaust purge valve coupled to the exhaust line to open.
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17. An electronic controller as in Claim 16 wherein the exhaust purge valve is a normally open valve.

18. An electronic controller as in Claim 16 wherein purge gas is directed into the exhaust line by cycling between opening and closing the exhaust purge valve.
19. An electronic controller as in Claim 16 wherein the electronic controller is further configured to preempt any attempts from any other systems to control the exhaust purge valve until the potentially unsafe situation is corrected.
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20. An electronic controller as in Claim 13 wherein a potentially unsafe situation includes any of: a loss of power in the cryopump; or a temperature of the cryopump greater than or equal to a predetermined temperature threshold; or an inability to determine a temperature of the cryopump.
- 10 21. An electronic controller as in Claim 20 wherein the electronic controller is further configured to respond to a loss of power in the cryopump by:
determining an operating state of the cryopump when the power loss occurred; and
if the operating state indicates that the cryopump was in a cool down phase of regeneration when the power loss occurred, initiating a regeneration cycle.
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22. An electronic controller as in Claim 13 wherein the controller is further configured to determine if regeneration is necessary after the potentially unsafe situation changes to a safe situation.
- 20 23. An electronic controller as in Claim 13 wherein the electronic controller is further configured to prevent a regeneration routine from occurring when a gate valve of the cryopump is open.
24. A cryopump comprising:

a cryopump chamber having pumping surfaces;
a normally open purge valve coupled to the cryopump; and
an electronic controller integral with the cryopump, the controller
responding to an unsafe state in the cryopump by closing the purge valve for a
5 safe period of time, and if the unsafe state remains after the safe period of time
elapses, the controller further responds by directing the purge valve to open to
deliver purge gas into the cryopump.

- 10 25. A cryopump as in Claim 24 wherein the purge gas is delivered into the
cryopump by further directing the purge valve to cyclically open and close until
the unsafe state changes to a safe state.
- 15 26. A cryopump as in Claim 24 wherein the controller further responds to the unsafe
state by preempting any attempts from any other systems to control the purge
valve while the purge gas is being delivered into the cryopump.
- 20 27. A cryopump as in Claim 24 further includes:
an exhaust system coupled to the cryopump;
an exhaust purge valve coupled to the exhaust system, wherein the
controller is further responds to the unsafe state by directing the exhaust purge
valve to open to deliver purge gas into the exhaust system.
- 25 28. A cryopump as in Claim 27 wherein the controller further responds to the unsafe
state by directing the exhaust purge valve to cyclically open and close until the
unsafe state changes to a safe state.
29. A cryopump as in Claim 27 wherein the controller further responds to the unsafe
state by preempting any attempts from any other systems to control the exhaust
purge valve until the unsafe state changes to a safe state.

30. A cryopump as in Claim 24 wherein an unsafe state exists when there is any one
of: a power failure of the cryopump; or a temperature of the cryopump greater
than or equal to a temperature threshold; or a failure to receive a temperature
reading from the cryopump.
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31. A cryopump as in Claim 24 wherein the controller further responds to a power
failure of the cryopump by:
determining an operating state of the cryopump before the power failure;
and
10 if the operating state indicates that the cryopump was in a process of
regeneration when the power failed, determining whether a regeneration process
should be initiated.
32. A cryopump as in Claim 24 wherein an unsafe state changes to a safe state after
a predetermined amount of time has elapsed.
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33. A cryopump as in Claim 24 wherein the controller is configured to prevent a
regeneration process from occurring while a gate valve of the cryopump is open.
34. A system for controlling a cryopump, the system comprising:
a means for coupling local electronics to a cryopump;
a means for using the local electronics to respond to a potentially unsafe
20 condition in the cryopump by:
retaining a normally open purge valve closed for a predetermined
period of time; and
after the predetermined period of time elapses, allowing the purge
valve to open to deliver purge gas into the cryopump.

35. A method for controlling a cryopump, the method comprising:
 - in response to a power failure, using power from at least one capacitor cell to hold a purge valve closed; and
 - in the at least one capacitor cell, storing an amount of energy which is discharged within a discharge time, the discharge time being a safe time by 5 which the purge valve must open.
36. A method for controlling a cryopump as in Claim 35 further includes causing a cryo-purge valve to open when all the energy stored in the cell is discharged.
37. A method for controlling a cryopump as in Claim 35 wherein the amount of 10 energy stored in the cell is used as a timing mechanism.
38. A method for controlling a cryopump as in Claim 35 wherein the at least one capacitor cell is an electrochemical cell.
39. A method for controlling a cryopump as in Claim 35 wherein the response to the power failure further includes:
 - 15 causing an exhaust valve coupled to a exhaust line of the cryopump to open; and
 - causing a gate valve coupled to the cryopump to close.
40. A method for controlling a cryopump as in Claim 35 wherein the discharge time is less than 5 minutes.
- 20 41. A method for controlling a cryopump as in Claim 35 further includes a delay circuit which causes the purge valve to open in a time less than the discharge time.

42. A method for controlling a cryopump as in Claim 40 wherein the time less than the discharge time is 2 minutes.

43. A cryopump controller which responds to a power failure comprising:
5 at least one capacitor cell;
 a delay that is powered using the at least one capacitor cell, the delay responding to a power failure by causing a purge valve to remain closed; and
 the capacitor cell storing an amount of energy which is discharged within a discharge time, the discharge time being a safe time by which the purge valve
10 must open.

44. A cryopump controller as in Claim 43 wherein the controller causes a purge valve to open when all the energy stored in the cell is discharged.

45. A cryopump controller as in Claim 43 wherein the amount of energy stored in the cell is used as a timing mechanism.

15 46. A cryopump controller as in Claim 43 wherein the capacitor cell is an electrochemical cell.

47. A cryopump controller as in Claim 43 wherein the controller responds to the power failure by:

20 causing an exhaust valve coupled to a exhaust line of the cryopump to open; and
 causing a gate valve coupled to the cryopump to close.

48. A cryopump controller as in Claim 43 wherein the discharge time is less than 5 minutes.

49. A cryopump controller as in Claim 43 further including a delay circuit which causes the purge valve to open in a time less than the discharge time.
 50. A cryopump controller as in Claim 50 wherein the time less than the discharge time is 2 minutes.
- 5 51. A cryopump including:
at least one capacitor cell;
a delay which is powered from the at least one capacitor cell, the delay responding to a power failure by directing a purge valve coupled to the cryopump to remain closed; and
10 the capacitor cell storing an amount of energy which is discharged within a discharge time, the discharge time being a safe time by which the purge valve must open.
52. A cryopump as in Claim 51 wherein the delay causes the purge valve to open when all the energy stored in the cell is discharged.
- 15 53. A cryopump as in Claim 51 wherein the amount of energy stored in the cell is used as a timing mechanism.
54. A cryopump as in Claim 51 wherein the capacitor cell is an electrochemical cell.
55. A cryopump as in Claim 51 wherein the cryopump includes electronics which respond to the power failure by:
20 causing an exhaust valve coupled to a exhaust line of the cryopump to open; and
causing a gate valve coupled to the cryopump to close.

56. A cryopump as in Claim 51 wherein the discharge time is less than 5 minutes.
57. A cryopump as in Claim 51 further including a delay circuit which causes the purge valve to open in a time less than the discharge time.
58. A cryopump as in Claim 57 wherein the time less than the discharge time is 2 minutes.
59. A system for controlling a cryopump, the system comprising:
 - a means for holding a purge valve closed using power from at least one capacitor cell in response to a power failure; and
 - 10 a means storing in the at least one capacitor cell an amount of energy which is discharged within a discharge time, the discharge time being a safe time by which the purge valve must open.
60. A method to energize a mechanism for a safe period of time, the method comprising:
 - 15 in at least one capacitor cell, storing an amount of energy which is discharged within a discharge time, the discharge time being a safe time by which the mechanism must be de-energized; and
 - responding to a power failure by energizing the mechanism with the stored energy.
61. A method according to Claim 60 wherein the mechanism includes a first state and second state, the first state being a de-energized state for potentially dangerous situations and the second state being an energized state for normal operation.